REMARKS

Consideration of this application as amended is respectfully requested.

The abstract, specification, claims and drawings have been amended to correct minor informalities of which the undersigned has become aware.

Submitted herewith are marked copies of the changed pages of the abstract, specification and claims to show that no new matter has been added.

And also submitted herewith is a copy of Fig. 1 marked in red to correctly identify the section line shown therein with Roman numerals, a corrected sheet of formal drawing which incorporates the amendment, and a Letter to the Official Draftsperson requesting approval thereof.

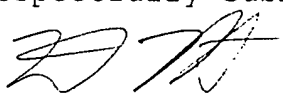
It is respectfully requested that the amendments to the abstract, specification, claims and drawings be approved and entered.

And it is respectfully submitted that the amendments to the claims are not related to patentability and do not narrow the scope of the claims either literally or under the doctrine of equivalents.

In view of the foregoing, it is respectfully requested that prosecution on the merits proceed in light of this Preliminary Amendment.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,



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VERSION MARKED TO SHOW CHANGES MADE

LENS DRIVING DEVICE

This application claims the benefit of Japanese Application No. 2000-361714 filed in Japan on November 28, 2000, the contents of which are incorporated herein by ~~this~~ a reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a lens driving device which performs movement and aperture opening and closing of a lens optical system in an optical device.

2. Description of the Related Art

The disclosure in Japanese Patent Laid-open No. 11-287941, regarding a lens driving device which performs movement and aperture opening and closing of a lens optical system, applied to electronic cameras, photoenlargers, and other optical equipment of the prior art, relates to a lens driving method which performs lens movement driving and aperture driving by means of a single driving source.

In the above conventional lens driving device, a dead zone portion is provided in the cam formed in the lens barrel. When the lens moves and is positioned in the above dead zone portion, the aperture is opened and closed by rotation of the above lens barrel. By reversing rotation of the lens barrel,

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moving the lens in the backward direction with the above aperture opening maintained, modification of the magnifying power, focus driving, and aperture opening and closing, can each be performed by a single driving source.

However, in the lens driving device disclosed in the above-mentioned Japanese Patent Laid-open No. 11-287941, when setting the aperture the lens must be returned to the initial position, and when combining an arbitrary aperture value with a specific lens position, a considerable time is required. Also, a driving plate must be used when performing aperture driving, so that the outer diameter of the lens barrel is increased, and there is the problem that the equipment in which the above device is incorporated increases in size.

SUMMARY OF THE INVENTION

This invention was devised in order to resolve the above-mentioned problems, and has as an object to provide a lens driving device which enables the setting of the combination of a prescribed zoom value and an arbitrary aperture value, by means of a simple configuration.

~~One~~ A lens driving device according to one aspect of this invention ~~has a lens optical system~~ comprises a lens optical system having a moving lens group movable along a direction of an optical axis, ~~the~~ and a focal length ~~of the lens optical system~~ which can be altered in stages

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among a plurality of values; a moving lens group frame holding the moving lens group; an aperture device provided within the lens optical system and ~~modifying the~~ having an aperture value which can be modified; a single driving source for changing the focal length value of the lens optical system and the aperture value of the aperture device; and a driving member driven by the single driving source ~~and~~ for performing driving to ~~change~~ move the moving lens group frame to achieve a desired focal length value of the lens optical system from ~~one of~~ among the plurality of focal length values, and for then performing driving to change the aperture value of the aperture device while maintaining the desired focal length value; ~~and in which the above~~ whereby the driving member is driven by the ~~above~~ single driving source, and by this means the lens optical system is driven and ~~moreover~~ the ~~above~~ aperture device is driven.

Another lens driving system according to a second aspect of this invention comprises ~~has two or~~ at least two more moving lens group frames, each capable of different movement in ~~the~~ an optical axis direction; an aperture device provided in one of the moving lens group frames; a cam member including: (i) at least two ~~or more~~ lens driving cams each having a first cam portion and a second cam portion, that ~~the first cam portion and the second cam portion~~ are formed successively to drive corresponding moving lens groups, and (ii) a third cam portion formed separately from the lens driving cams; wherein the first cam portion is provided in a range in which the moving lens group frames are driven

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a first-group lens frame and aperture ring ~~comprised by~~ of the lens barrel of the above aspect;

Fig. 3 is an expanded view of the cam grooves of the fixed frame and cam ring comprised by the lens barrel of the above aspect;

Fig. 4A is an expanded view of a state of operation showing a state in which the cam follower of the lens frame and the aperture driving pins of the aperture ring are driven by the cam ring comprised by the lens barrel of the aspect of the above Fig. 1, and shows a state in which the cam follower has reached the wide-angle stopping region;

Fig. 4B is an expanded view of a state of operation showing a state in which the cam follower of the lens frame and the aperture driving pins of the aperture ring are driven by the cam ring comprised by the lens barrel of the aspect of the above Fig. 1, and shows a state in which the aperture driving pins have reached an arbitrary aperture position;

Fig. 4C is an expanded view of a state of operation showing a state in which the cam follower of the lens frame and the aperture driving pins of the aperture ring are driven by the cam ring comprised by the lens barrel of the aspect of the above Fig. 1, and shows a state in which the aperture driving pins have reached the aperture-open position;

said moving lens group frame in the optical axis direction; and

an aperture driving cam formed separately from said lens driving cam ~~and~~ for performing driving to change the aperture value of said aperture device when said moving lens group frame is in a state of not being displaced in the optical axis direction due to said moving lens group frame being in said ~~second cam region.~~

3. The lens driving device according to Claim 2, wherein:

said driving member ~~is~~ comprises a cam ring of cylindrical shape having a substantially uniform wall thickness; and

said lens driving cam and said aperture driving cam are formed in ~~this~~ the cam ring of cylindrical-shape ~~member~~ as cam holes or as cam grooves.

4. The lens driving device according to Claim 2, wherein:

said aperture driving cam is formed ~~such that~~ so as not to change the aperture value of said aperture device ~~does not change within said first cam region in which there is~~ during driving displacement of said moving lens group frame in the ~~optical axis direction~~ first cam region.

5. The lens driving device according to Claim 2, further comprising an impelling member, provided in said aperture device, which impels said aperture device in a prescribed direction such

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~~source,~~ said aperture device can be driven to modify the aperture value while maintaining the desired focal length value.

9. A lens driving device, comprising:

~~two or more~~ moving lens group frames, each capable of different movement in ~~the~~ optical axis direction;

an aperture device provided in one of said moving lens group frames;

a cam member including at least two ~~or more~~ lens driving cams each having a first cam portion and a second cam portion ~~said first cam portion and said second cam portion~~ are formed successively to drive corresponding moving lens groups, and a third cam portion formed separately from said driving cams;

wherein:

→ said first cam portion is provided in a range in which said moving lens group frames are driven and displaced in the optical axis direction;

→ said second cam portion is provided in a range in which said moving lens group frames are not driven and displaced in the optical axis direction; and

→ said third cam portion ~~which~~ when said moving lens group frames are in a state of not being displaced in the optical axis direction due to said moving lens group frames being in the range of said second cam portion drives said aperture device to change the aperture value ~~drives said aperture device to modify the aperture value; and~~

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said aperture device

aperture device, which impels in a prescribed direction such that the aperture value of said aperture device assumes a value determined in advance; and wherein

while ~~in said first cam portion in which~~ said moving lens group frame ~~is~~ are driven and displaced in the ~~optical axis direction~~ first cam portion, said aperture value of said aperture device ~~assumes the state of~~ attains said aperture value set in advance by means of the impelling force of said impelling member, without said aperture device being engaged with said ~~aperture driving cam~~ third cam portion.

14. The lens driving device according to Claim 9, wherein said aperture device is impelled in ~~the~~ a direction in which ~~the~~ an aperture diameter is decreased.

15. The lens driving device according to Claim 9, wherein said cam member is formed such that, ~~after~~ said moving lens group frames are ~~optical system is~~ driven in one direction only to ~~be modified to~~ achieve a desired focal length value, ~~among said plurality of focal length values through driving, in one direction only, by said single driving source,~~ and said aperture device can then be driven to modify the aperture value while maintaining the desired focal length value.

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ABSTRACT ~~OF THE DISCLOSURE~~

A lens barrel incorporating a lens driving device ~~has~~ is provided which includes a fixed frame, a cam ring inserted into the fixed frame in freely rotatable fashion, first and second group lens frames inserted into the cam ring enabling free forward and backward motion, and an aperture ring supported by the first group lens frame in a freely rotatable manner. In the ~~above~~ cam ring, there are provided a diagonal cam groove which drives the first and second group lens frames to zoom positions in stages, circumferential-direction cam grooves which hold each zoom position, and aperture cam grooves which drive the aperture ring. In a state in which the first and second group lens frames are positioned and fixed at respective zoom positions, the cam ring can be rotated to rotate the aperture ring, thereby setting the aperture value of the pickup lenses. By means of the lens driving device of this lens barrel, a simple configuration can be used to combine and set a prescribed zoom value and an arbitrary aperture value.

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